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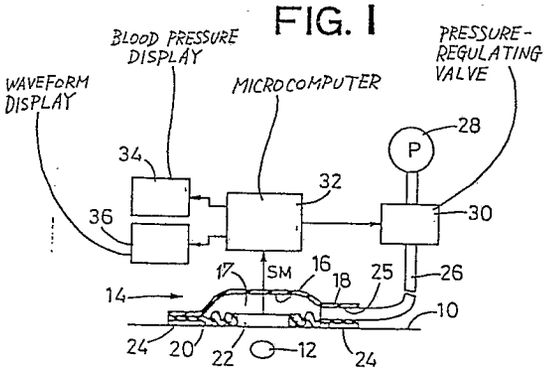
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(54) Pulse wave detecting apparatus.

(57) A pulse wave detecting apparatus having a housing (18, 42, 48) which is fixed to a body surface (10) of a subject, a pressing device (20, 38, 44, 50) accommodated in the housing for pressing an artery (12) of the subject via the body surface, and a pulse wave detecting device (22, 40) for detecting pulse wave of the artery which is produced in relation with the pressing of the pressing means, the apparatus including an adhesive member (24) mounted on the housing, for adhering the housing to the body surface of the subject with an adhesive force higher than the pressing force of the pressing device.

FIG. I



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Description

PULSE WAVE DETECTING APPARATUS

The present invention relates to improvements in a pulse wave detecting apparatus.

There has been proposed a pulse wave detecting apparatus having a pressing means for pressing an arterial vessel located near a body surface of a subject, for example a radial artery near a wrist of the subject, the pressing means being fixed on the body surface such that the pressing means is aligned with the arterial vessel. The pulse wave detecting apparatus has a pulse wave detecting means for detecting pulse waves of the arterial vessel which are produced by expansion and contraction of the vessel synchronized with heart beat of the subject as a result of the pressing of the pressing means. Further, the apparatus is provided with a fixing means for fixing the pressing means to the body surface over the arterial vessel, for example a band having at both ends thereof a pair of engaging members such as a pair of slide fasteners. With the band wound around a body portion of the subject, for example a wrist of the subject, and fastened by the engaging members, the pressing means is fixed in place over the arterial vessel of the subject.

However, it is considerably time-consuming to fix the pressing means on the body surface over the arterial vessel by means of the band or other similar fixing means.

It is therefore an object of the present invention to provide a pulse wave detecting apparatus wherein the housing thereof accommodating the pressing means thereof is more easily fixed to a body surface over an arterial vessel.

The above object has been achieved by the present invention, which provides a pulse wave detecting apparatus having (a) a housing which is to be fixed to a body surface of a subject, (b) pressing means accommodated in the housing, for pressing an artery of the subject via the body surface, and (c) pulse wave detecting means for detecting pulse waves of the artery which are produced in relation with the pressing of the pressing means, the apparatus including (d) an adhesive member mounted on the housing, for adhering the housing to the body surface of the subject with an adhesive force higher than the pressing force of the pressing means.

In the pulse wave detecting apparatus constructed as described above, the adhesive member mounted on the housing is adhered to around the body surface right above the artery. Subsequently the pressing means is activated to press the artery, and the produced pulse wave is detected by the pulse wave detecting means. Thus, the housing and accordingly the pressing means accommodated therein are easily fixed in place on the body surface over the artery by simply adhering to the body surface the adhesive member secured to the housing. Thus, the present pulse wave detecting apparatus is more easily handled than the conventional apparatus of the above-mentioned type.

In a preferred embodiment of the pulse wave detecting apparatus of the present invention, the pressing means includes a diaphragm which is inflated by fluid pressure applied thereto, and the pulse wave detecting means consists of a pressure sensor which is accommodated in the housing and is pressed against the body surface by the inflated diaphragm so as to detect pressure variation produced at an interface between the pressure sensor and the body surface, the detected pressure variation representing the pulse wave produced in relation with the pressing of the diaphragm.

In another embodiment of the apparatus of the invention, the pressing means consists of a diaphragm which is inflated by fluid pressure applied thereto, and the pulse wave detecting means detects pressure variation produced in a space defined by at least the diaphragm, the detected pressure variation representing the pulse wave. In this embodiment, the pulse wave detecting means may be accommodated in the housing. Alternatively, the pulse wave detecting means may be located outside the housing, and connected to the housing via a pipe.

In yet another embodiment of the apparatus of the invention, the pressing means consists of a bag which is inflated by fluid pressure applied thereto, and the pulse-wave detecting means detects pressure variation in the bag, the detected pressure variation representing the pulse wave.

In a further embodiment of the apparatus of the invention, the housing is formed of synthetic resin and has a generally disk-like configuration with a comparatively shallow cavity, and the adhesive member consists of an adhesive sheet fixed to the disk-like housing along a circumference of the housing, the adhesive sheet being adhered to the body surface with the adhesive force.

By way of example, the present invention will be better understood by reading the following detailed description of the presently preferred embodiment of the invention, when considered in conjunction with the accomapying drawings, in which:

Fig. 1 is an illustrative view showing a pulse wave detecting apparatus of the present invention;

Fig. 2 is a perspective view showing a pulse wave detecting probe of the apparatus of Fig. 1;

Figs. 3 through 5 are cross-sectional views of other pulse wave detecting probes which are employed in the apparatus of Fig. 1; and

Figs. 6 and 7 are cross-sectional views partly showing other adhesive sheets which are empolyed in the apparatus of Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to Fig. 1, there is shown a pulse wave detecting apparatus embodying the present invention. In the figure, reference numeral 10 designates a body surface of a subject, and reference numeral 12 designates an arterial vessel

near the body surface, for example a radial artery. A pulse wave detecting probe 14 is closely adhered to the body surface 10 right above the artery 12.

The pulse wave detecting probe 14 includes a housing 18, a pulse wave sensor 22, a diaphragm 20 and an adhesive sheet 24. The housing 18 has a generally disk-like configuration as shown in Fig. 2, and has a comparatively shallow cavity 16 at a central portion thereof. The housing 18 is formed of an engineering plastic film, and has a comparatively high rigidity. The pulse wave sensor 22 has a strain gauge, piezoelectric element or the like. The diaphragm 20 is fluid-tightly secured at a peripheral portion thereof to a peripheral portion of the disk-like housing 18 along a circumference thereof, and also to a side surface of the pulse wave sensor 22, so that the diaphragm 20 defines a fluid-tight space 17 in the housing 18. The diaphragm 20 is formed of rubber and has a generally annular configuration. The adhesive sheet 24 has a generally annular configuration, and is secured to one surface of the peripheral portion of the diaphragm 20, the other surface of the diaphragm 20 being fixed to the housing 18. The fluid-tight space 17 (shallow cavity 16) is supplied with a pressurized fluid from an electrically operated pump 28 via a pipe 26 inserted in a passage 25 provided at the peripheral portion of the probe 14. Pressure level in the fluid-tight space 17 is adjusted by a pressure-regulating valve 30. The fluid may be either a non-compressive fluid such as water or oil, or a compressive fluid such as air or carbonic-acid gas.

The pulse wave sensor 22 is supported by the diaphragm 20 such that the sensor 22 defines a part of a bottom surface of the pulse wave detecting probe 14 which surface contacts the body surface 10 when the probe 14 is placed on the body surface 10 and to which surface the adhesive sheet 24 is fixed. If the electrically operated pump 28 is operated to supply the fluid-tight space 17 with the pressurized fluid, the diaphragm 20 is inflated and thereby presses the artery 12 via the body surface 10. The pulse wave sensor 22 detects pressure variation produced at an interface between the sensor 22 and the body surface 10, the detected pressure variation representing pulse wave of the artery 12 which is produced in synchronization with heart beat of the subject as a result of the pressing of the diaphragm 20. The sensor 22 generates electrical signal SM representing the thus-detected pulse wave, to a microcomputer 32. In the present embodiment, the diaphragm 20 serves as the pressing means of the pulse wave detecting apparatus, while the pulse wave sensor 22 serves as the pulse wave detecting means.

The microcomputer 32 includes a CPU (central processing unit), a RAM (random access memory), a ROM (read only memory) and an I/O interface (all not shown). The CPU processes the input signal (pulse wave signal SM) according to programs stored in the ROM by utilizing the temporary-storage function of the RAM, and controls the pressure level in the fluid-tight space 17 of the housing 18 through the pressure-regulating valve 30. More specifically described, upon operation of a start switch (not shown), the microcomputer 30 activates the pressure-regulating valve 30 to allow the pressurized fluid from the pump 28 to be supplied to the fluid-tight space 17. Subsequently, the microcomputer 30 calculates the magnitude of the pulse wave signal SM, for example the amplitude or electric power of the signal SM, and thereby determines whether or not the magnitude of the signal SM has been increased to an optimum level, for example whether or not the magnitude has been increased to a maximum level or saturated. When the magnitude of the signal SM has been increased to the optimum level, the microcomputer 32 commands the pressure- regulating valve 30 to maintain the current pressure level in the fluid-tight space 17 of the housing 18 by means of feed-back control. The CPU of the microcomputer 32 determines blood pressure of the subject based on the pulse wave signal SM, and commands a blood pressure display 34 to display the thus-determined blood pressure and concurrently commands a waveform display 36 to display the waveform of the pulse wave represented by the signal SM. Since an upper peak value of the pulse wave corresponds to a maximum blood pressure and a lower peak value of the pulse wave corresponds to a minimum blood pressure, actual blood pressure indicated by the blood pressure display 36 is determined according to a pre-determined relationship between the pulse wave and the blood pressure, and based on the actual upper and lower peak values of the pulse wave represented by the signal SM. Further, the waveform of the pulse wave indicated by the waveform display 36 represents variation in pulse pressure of the artery 12, and provides clinical or medical important information. One of the blood pressure display 34 and the waveform display 36 may be omitted.

There will be described below the operation of the instant pulse wave detecting apparatus. Initially, the pulse wave detecting probe 14 is fixed to the body surface 10 by closely adhering the adhesive sheet 24 secured to the housing 18 to the body surface 10 around right above the artery 12, such that the pulse wave sensor 22 is positioned right above the artery 12. Subsequently the fluid-tight space 17 is supplied with the pressurized fluid from the electrically operated pump 28, and the diaphragm 20 and sensor 22 are pressed against the artery 12 via the body surface 10. Thus, the pulse wave of the artery 12 is detected by the pulse wave sensor 22, which generates the pulse wave signal SM to the microcomputer 32. When the magnitude of the signal SM has come to an optimum level, for example when the magnitude has been increased to a maximum level or saturated, the microcomputer 32 (CPU) commands the pressure-regulating valve 30 to maintain the pressure level in the fluid-tight space 17 of the housing 18. Based on the pulse wave signal SM having the optimum magnitude, the microcomputer 32 determines the blood pressure of the subject and commands the devices 34, 36 to display the thus-determined blood pressure and waveform, respectively. The pulse wave detecting probe 14 (housing 18) is adhered to the body surface 10 by the adhesive sheet 24, with an adhesive force higher

than a maximum pressing force of the diaphram 20.

As is apparent from the foregoing, in the instant pulse wave detecting apparatus, the pulse wave sensor 22 is easily fixed to the body surface 10 over the artery 12 by simply adhering the adhesive sheet 24 to the body surface 10 around right above the artery 12 so that the adhesive sheet 24 is brought into close contact with the body surface. Thus, the instant apparatus is more easily handled than the coventional apparatus whose pulse wave sensor is adapted to be fixed on the body surface by winding and fastening a band or similar fixing means around a body member of a subject.

While the present invention has been described in its preferred embodiment, it is to be understood that the invention may be embodied with various modifications. There will be some modified pulse wave detecting probes. The same numerals as used in Figs. 1 and 2 are used to designate the corresponding elements in Figs. 3 through 7, and repetitive description of those elements are omitted.

While in the above-described embodiment the pulse wave sensor 22 is adapted to be directly pressed against the body surface 10, it is possible as shown in Fig. 3 to secure the sensor 22 to the wall of the housing 18 which wall defines the shallow cavity 16 and dispose a diaphragm 38 so as to define a fluid-tight space 17 in the housing 18. In this modified form, the sensor 22 detects pressure variation which is produced in the space 17 by oscillatory pressure wave transmitted from the artery 12 through the diaphragm 38 and the fluid in the space 17. The detected pressure variation represents pulse wave of the artery 12. The diaphragm 38 serves as the pressing means of the pulse wave detecting apparatus.

Another modified pulse detecting probe is shown in Fig. 4. In the figure, a pulse wave sensor 40 serving as the pulse wave detecting means is disposed outside a housing 42. A diaphragm 44 serving as the pressing means is secured to the housing 42 to define a fluid-tight space 17, which communicates the pulse wave sensor 40 via a pipe 46. The sensor 40 detects pressure variation (pressure oscillation) in the fluid-tight space 17 in the housing 18. The detected pressure variation represents pulse wave of the artery 12. In this modified form, it is recommended that the pressurized fluid used to inflate the diaphragm 44 be a non-compressible fluid.

Yet another modified pulse detecting probe is shown in Fig. 5. In a housing 48 of the probe, a bag 50 formed of a thin, synthetic resin film is accommodated such that the bag 50 is secured at its opening to the pipe 26 from which a pressurized fluid is supplied thereto. The housing 50 has a cavity 52 in which the bag 50 is inflated by the fluid pressure applied thereto. With the bag 50 inflated in the cavity 52, the pulse wave sensor 22 secured to the wall of the housing 48 is brought into close contact with the inflated bag 50. Thus, the sensor 22 detects pressure variation produced in the bag 50 by oscillatory pressure wave transmitted from the artery 12 through the thin films of the bag 50 and the fluid in the bag 50. The detected pressure variation represents pulse wave of the artery 12. In the present modified form, the bag 50 serves as the pressing means. It is preferred that the bag 50 be high in flexibility and be low in elasticity.

While in the illustrated pulse wave detecting probe of Figs. 1, 3 and 4 the adhesive sheet 24 is secured to the diaphragm 20, 38 and 40, respectively, it is possible to secure the adhesive sheet 24 to the housing 18, 42 as shown in Figs. 6 and 7. In this case, however, a portion of the housing 18, 42 where the pipe 26, 46 is inserted, is free from the adhesive sheet 24. In the arrangement shown in Fig. 6, a portion of the housing 18, 42 where the pipe 26, 46 is inserted, is free from a folded portion 18a, 42a thereof.

While the present invention has been described with detailed particularities of the preferred embodiment, it is to be understood that the invention may be embodied with other changes, improvements and modifications which may occur to those skilled in the art without departing from the spirit and scope of the invention defined in the following claims.

Claims

1. A pulse wave detecting apparatus having
a housing (18, 42, 48) which is to be fixed to a body surface (10) of a subject,
pressing means (20, 38, 44, 50) accommodated in said housing, for pressing an artery (12) of said subject via said body surface, and
pulse wave detecting means (22, 40) for detecting pulse waves of said artery which are produced in relation with the pressing of said pressing means,
the apparatus including:
an adhesive member (24) mounted on said housing (18, 42, 48), for adhering said housing to said body surface (10) of said subject with an adhesive force higher than the pressing force of said pressing means (20, 38, 44, 50).

2. The apparatus as set forth in claim 1, wherein said pressing means includes a diaphragm (20) which is inflatable by fluid pressure applied thereto, and said pulse wave detecting means consists of a pressure sensor (22) which is accommodated in said housing (18) and is pressed against said body surface (10) by the inflated diaphragm so as to detect pressure variation produced at an interface between said pressure sensor and said body surface, the detected pressure variation representing the pulse wave produced in relation with the pressing of said diaphragm.

3. The apparatus as set forth in claim 1, wherein said pressing means consists of a diaphragm (38) which is inflatable by fluid pressure applied thereto, and said pulse wave detecting means (22, 40) detects pressure variation produced in a space (17) defined by at least said diaphragm, the detected pressure variation representing said pulse wave.

4. The apparatus as set forth in claim 3, wherein said pulse wave detecting means (22)

is accommodated in said housing (18).

5. The apparatus as set forth in claim 3, wherein said pulse wave detecting means (40) is located outside said housing (42), and connected to said housing via a pipe (46).

6. The apparatus as set forth in claim 1, wherein said pressing means consists of a bag (50) which is inflated by fluid pressure applied thereto, and said pulse wave detecting means (22) detects pressure variation in said bag, the detected pressure variation representing said pulse wave.

7. The apparatus as set forth in any of claims 1-6, wherein said housing (18, 42, 48) is formed of synthetic resin and has a generally disk-like configuration with a comparatively shallow cavity, and said adhesive member consists of an adhesive sheet (24) fixed to said disk-like housing along a circumference of said housing, said adhesive sheet being adhered to said body surface (10) with said adhesive force.

FIG. 1

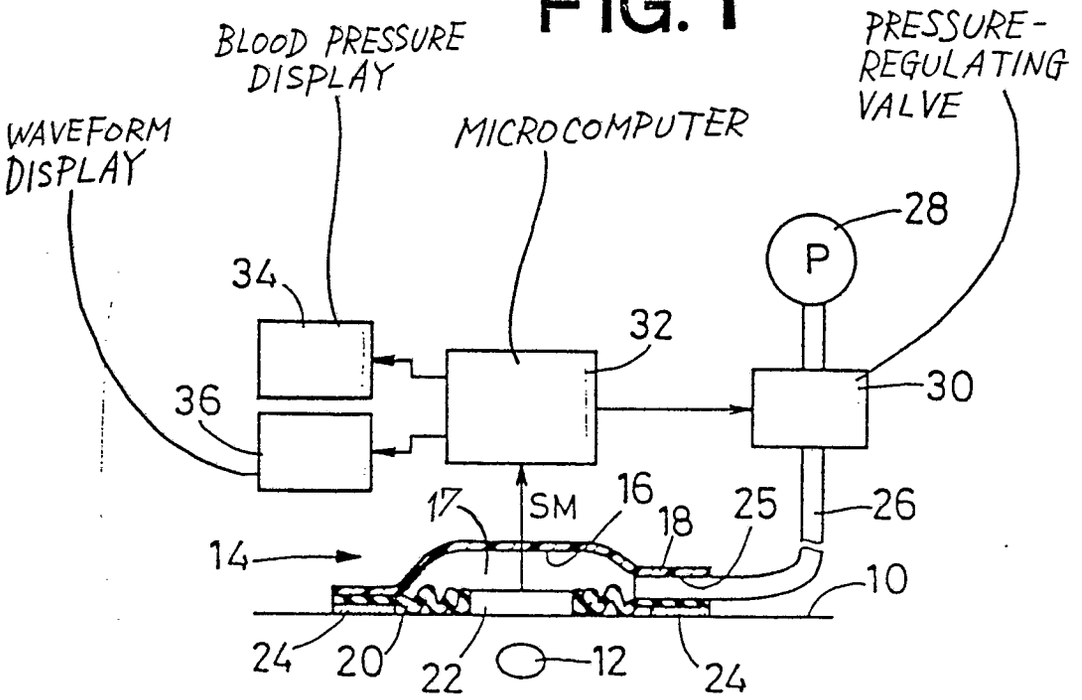


FIG. 2

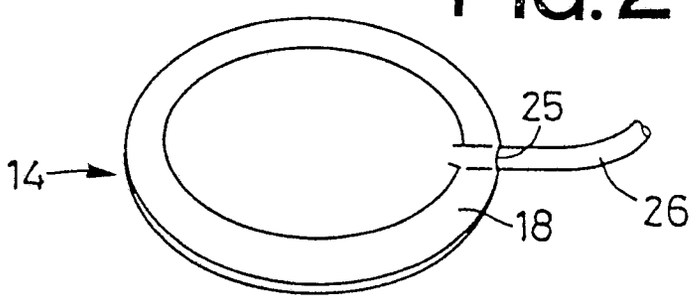


FIG. 3

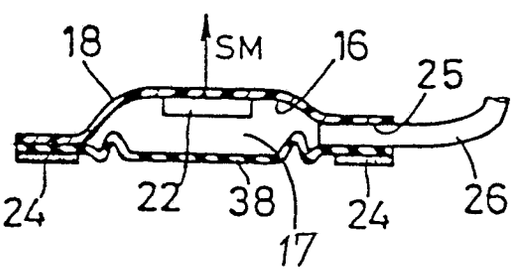


FIG.4

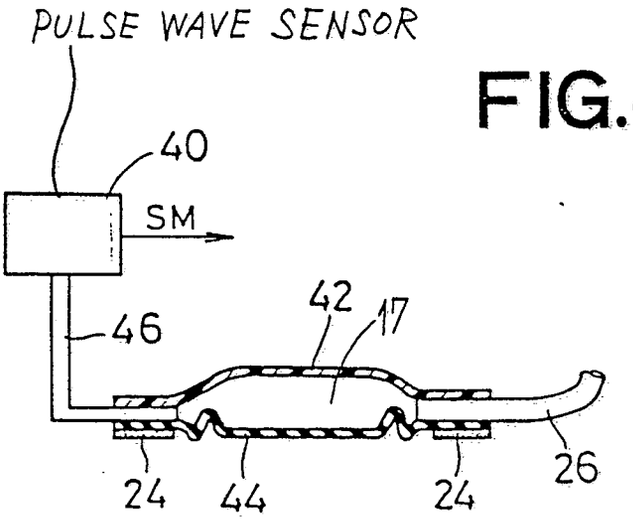


FIG.5

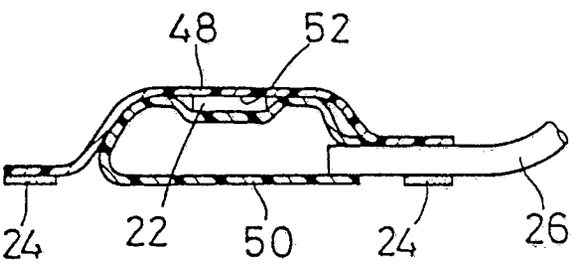


FIG.6

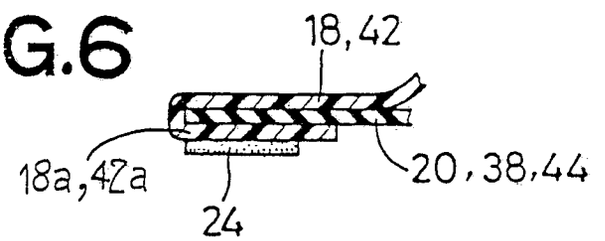
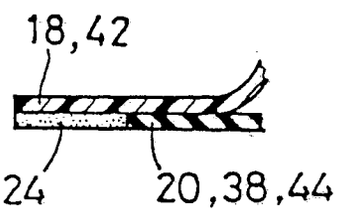


FIG.7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 0756

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	US-A-4 269 193 (J.S. ECKERLE) * column 6, line 11 - column 7, line 41; figure 5 *	1,7	A 61 B 5/02
A		2-4	
Y	DE-A-2 737 665 (SOMATRON BIOFEEDBACK GMBH) * page 8, line 12 - page 9, line 23; figure 1 *	1,7	
Y	EP-A-0 122 123 (CRITIKON INC) * page 7, line 21 - page 8, line 27; figure 1 *	1	
A		5,6	
A	DE-A-3 008 601 (ROBERT BOSCH GMBH) * page 3, line 16 - page 4, line 12, figure *	1-4	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

A 61 B 5/00
A 61 B 7/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	18-04-1989	WEIHS J.A.

CATEGORY OF CITED DOCUMENTS

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